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Analysis of blockchain in solar energy systems

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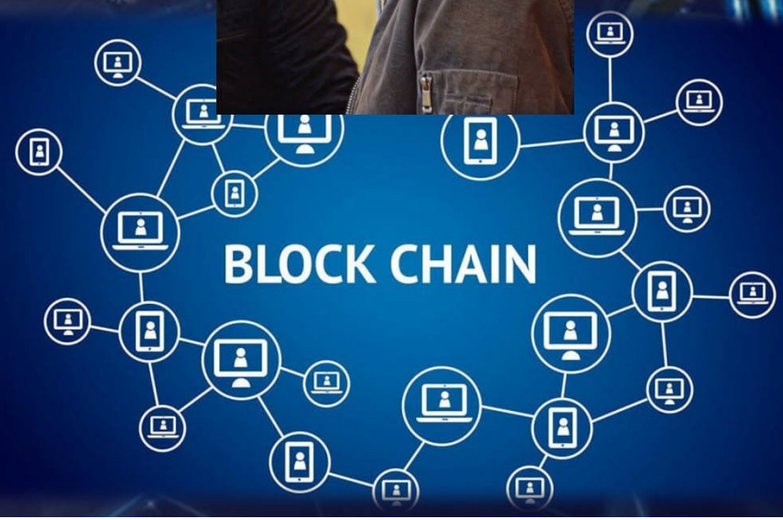

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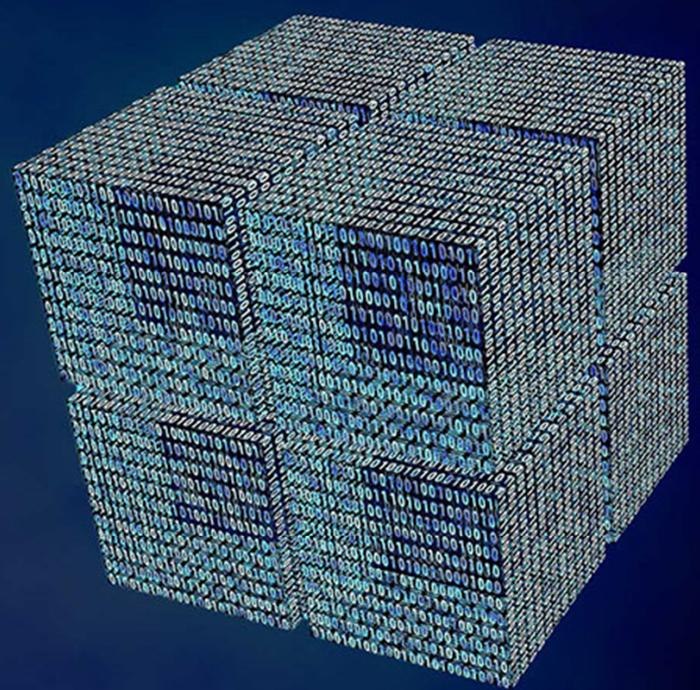
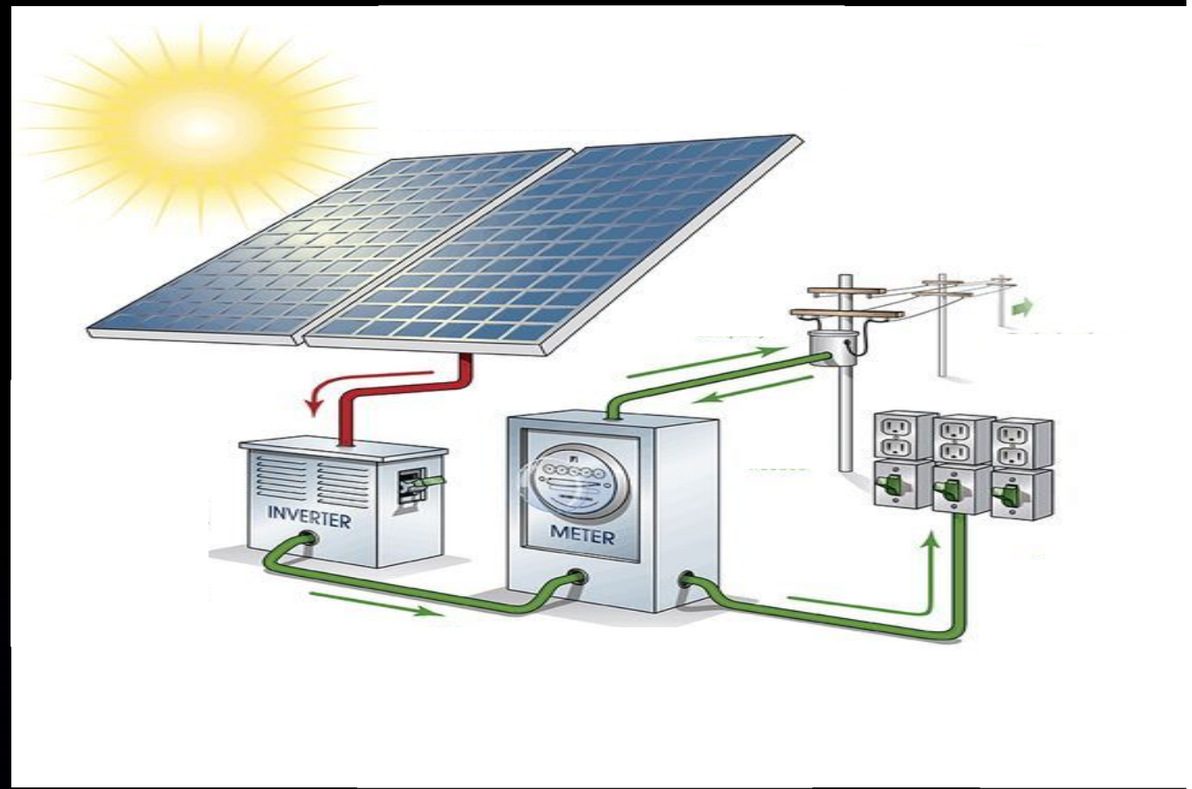
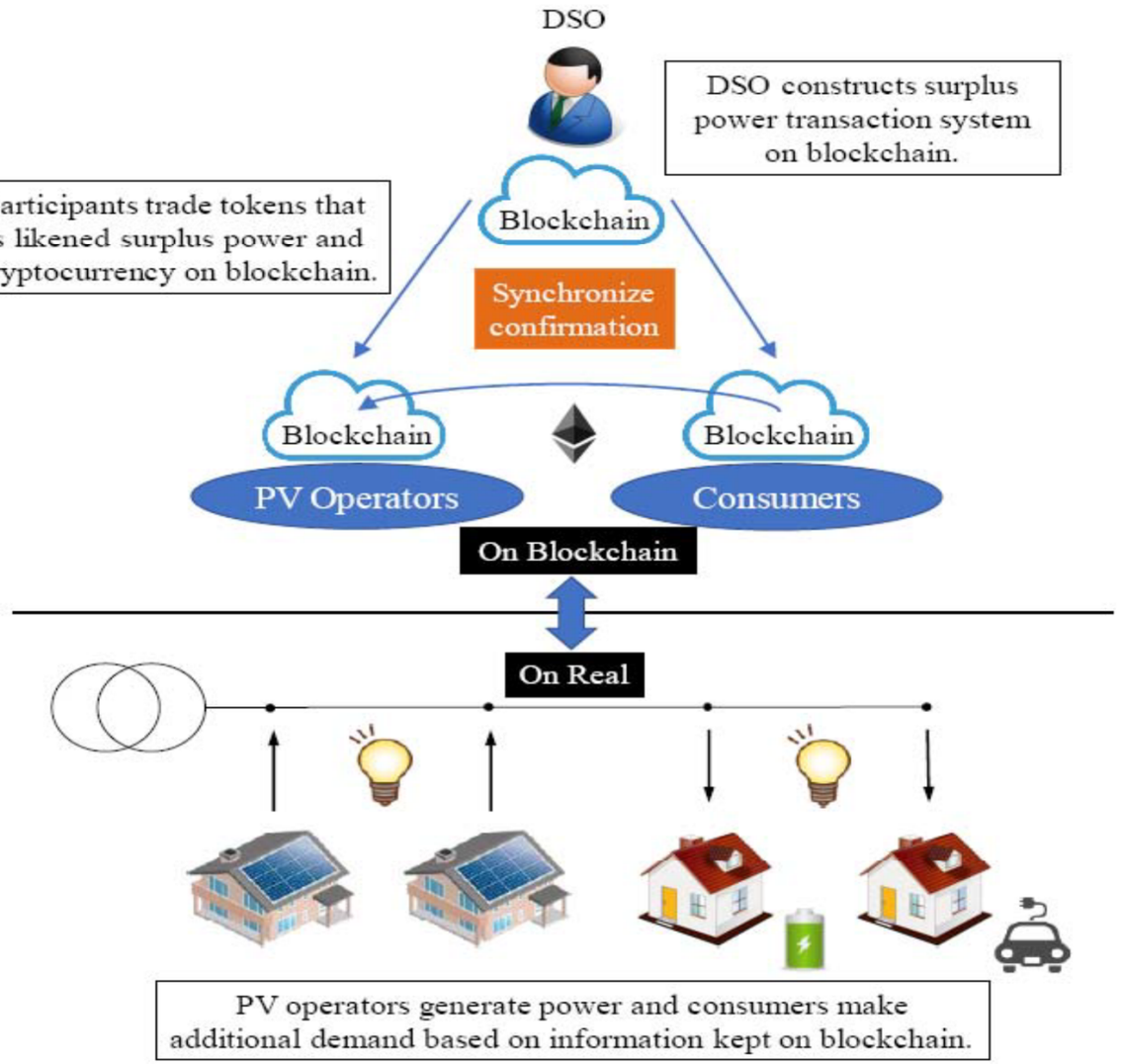


By this presentation , we are trying to shed light on the usage of the blockchain technology in the solar energy systems represented by the photovoltaic systems



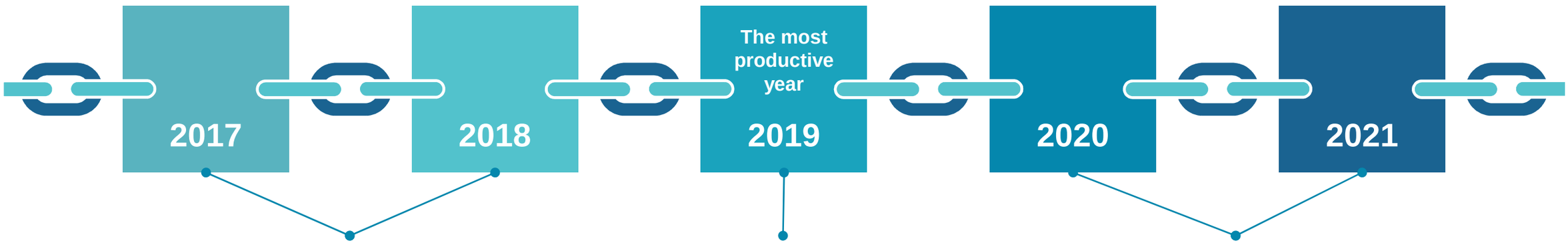
The general principle is self-consuming [1] the solar energy and trading the surplus, this system is called prosumer

1. Schema of an example of generation for trading solar energy [8]



Scientific Production Analysis

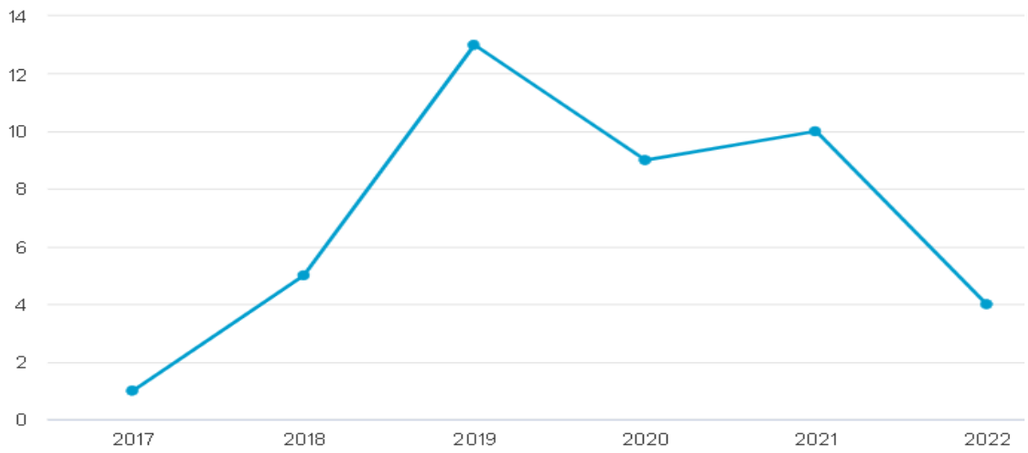
- **Paper by Year of production and source:**

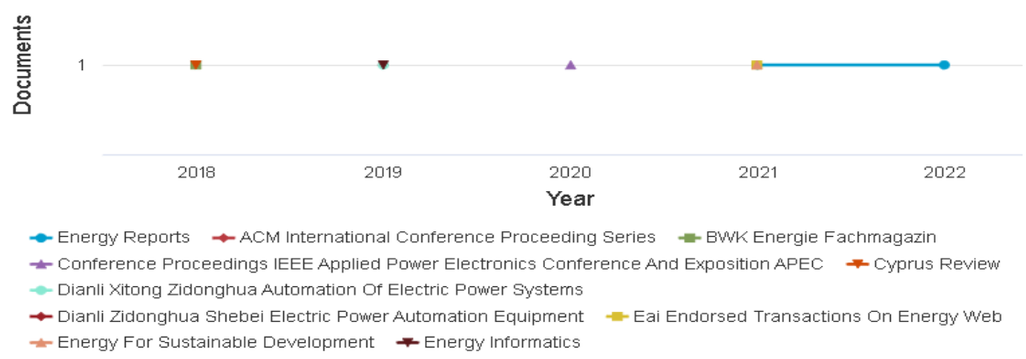


The emergence of the idea of integrating the blockchain technology in the energy industry

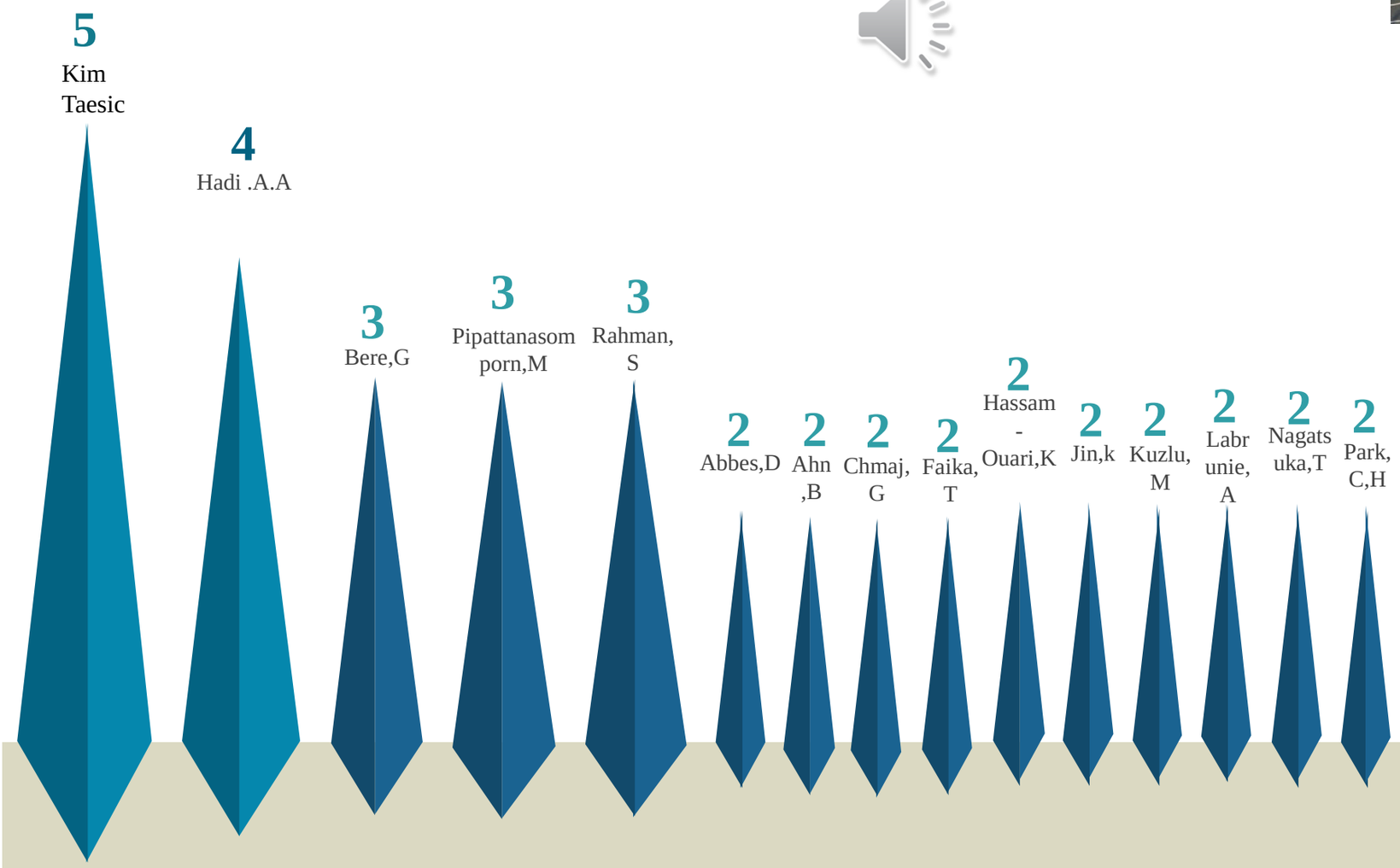
2019 WAS THE MOST PRODUCTIVE YEAR (13 PAPERS) YEAR IN THE NUMBER OF PAPERSS

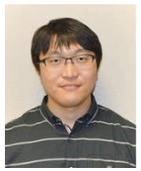
The rise of literature productivity after the pandemic And expectance of another rise in 2022 due the awareness of the world about the importance of digitalization of the citizens sides of life.



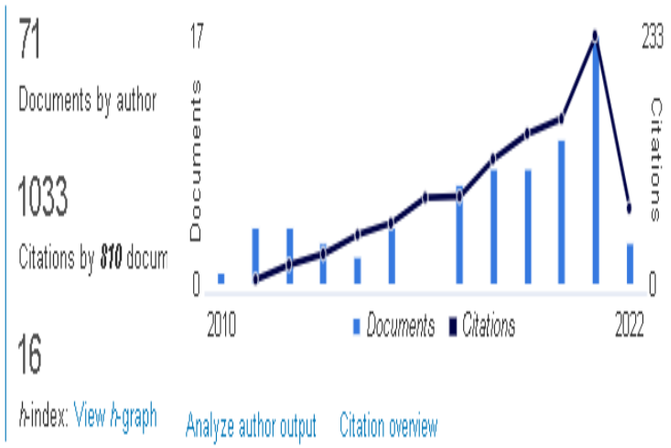


Number of papers by author



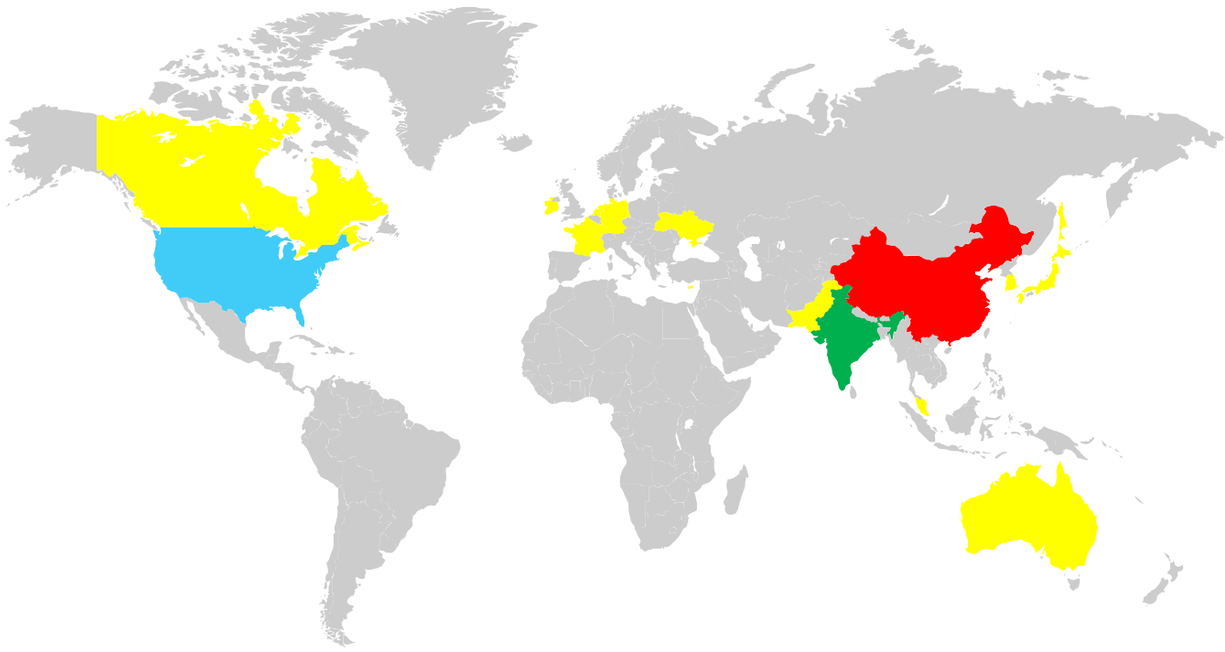


the first author in blockchain in PV energy (5 papers) is “Kim Taesic” affiliated to Texas A and M University Kingsville Kingsville, United States” since 2017. His research interests are principally: engineering, energy, computer science and Mathematics.



He has an h-index of 16 and 1033 citations on 71 published papers (Fig. 5), on energy and other domains

Number of papers produced by country



28,5%

United States

United States is the most productive country with 12 papers among 42

23,8 %

China

China published 10 papers among 42 papers

11,9 %

India

India published 5 papers among 42 papers

35,7 %

Others

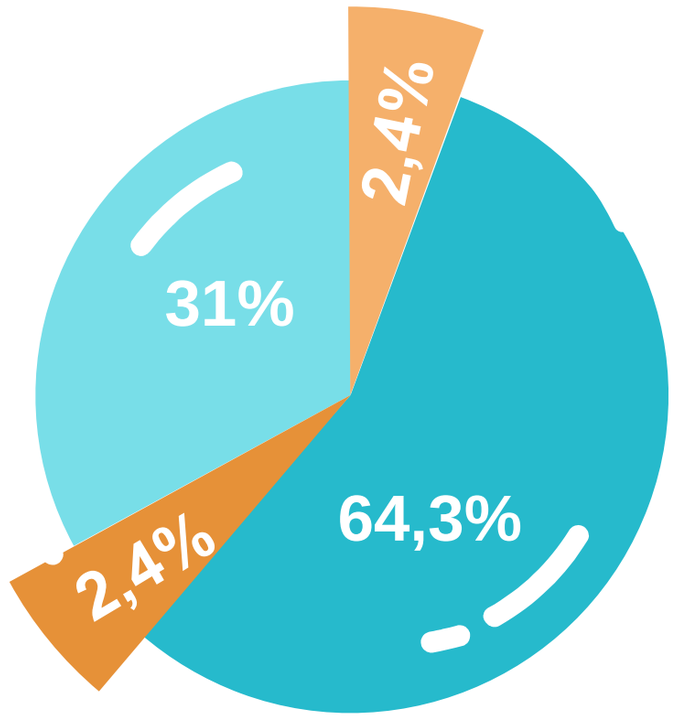
Other countries such as Canada, Australia,,,etc published in total 15 papers among 42

Number of papers by document type

The conference papers are majority (64,3%), ie 27, followed by journal articles (31%), ie 13 papers. It is remaining 1 paper as a review and 1 paper as a note

Article

Review

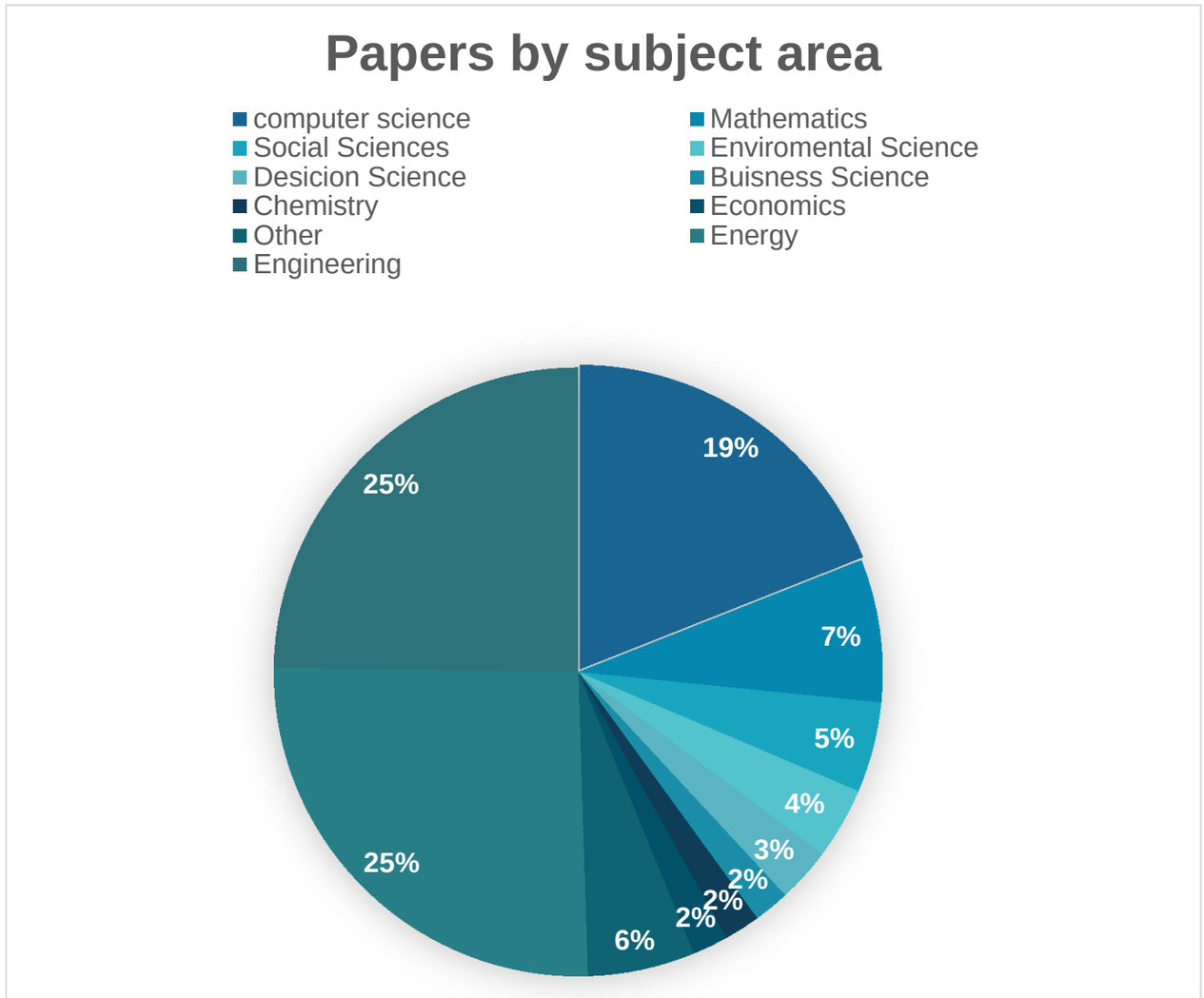


Note

Conference paper

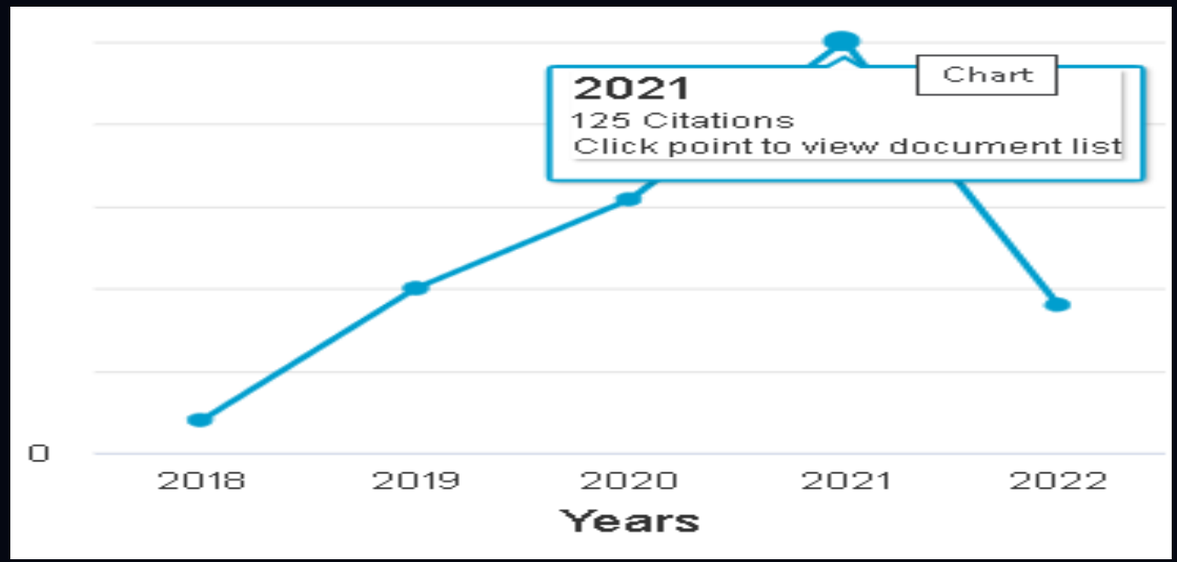
Papers by subject area

The papers are divided fairly on the subject areas of energy (27 papers) and Engineering (26 papers), in third position comes the computer science (20 papers). The remaining papers (Fig. 10) are shared on mathematics (8 papers), social science(5papers),environmental science (4 papers)…etc.



Citation Analysis

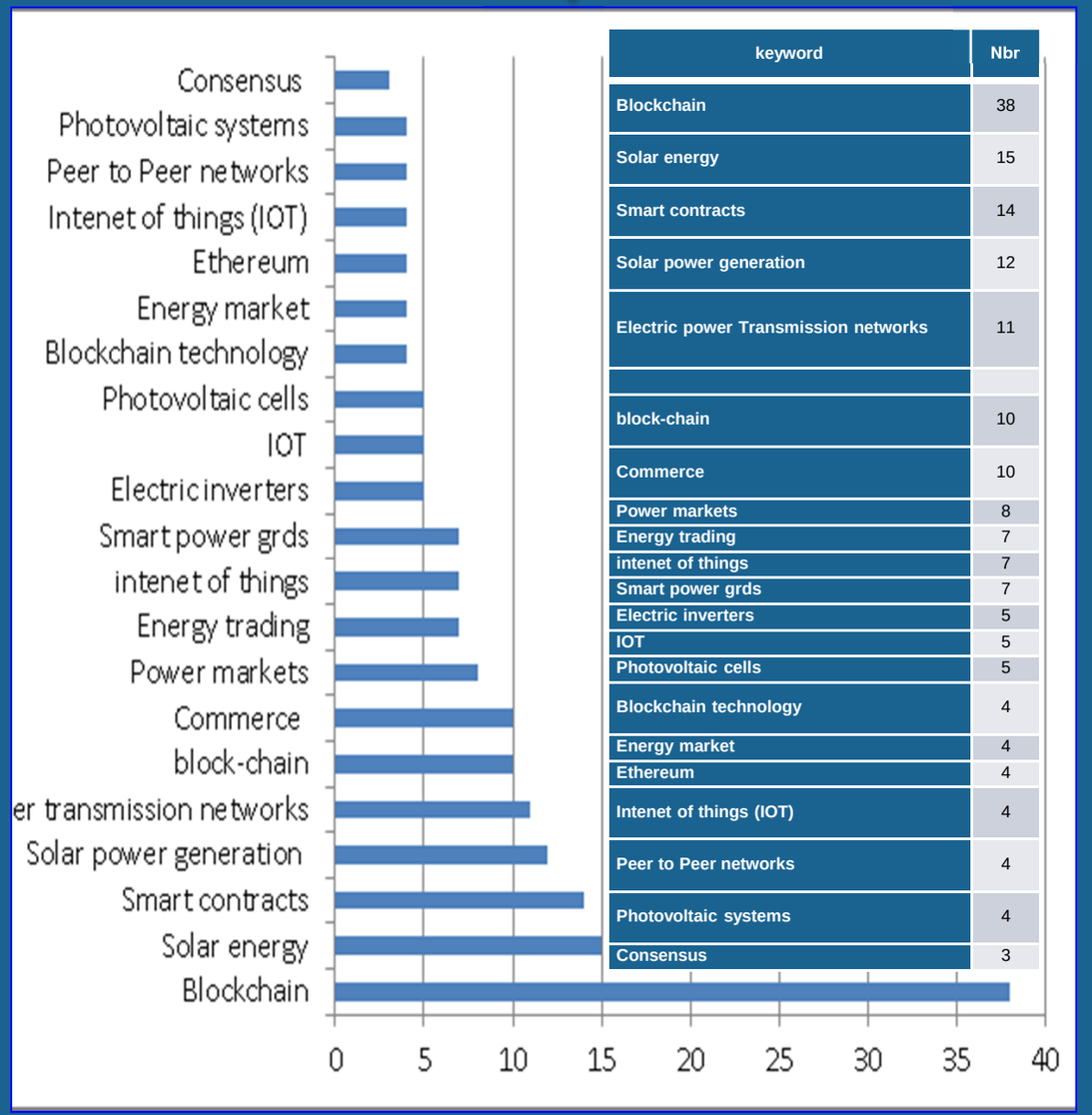
The citation analysis is the examination of the frequency and graphs of citations in documents . in this section we'll show different citation criteria to determine which paper contributed the most and in which year it appeared the most



The figure above shows that the citations are increasing over the years. Showing a growing intreste in strong and valid papers about energy , energy trading and blockchain technology .
Especially in the year 2021 where all eyes where headed towards cryptocurrency and blockchain.

KEYWORDS ANALYSIS

The keyword analysis is a quantitative and qualitative analysis of a paper. The most used words in the titles are “blockchain” and “solar energy”; of course, the request to have these words in the research in SCOPUS database. “block-chain” is appeared 10 times. The remaining keywords are “Smart contracts” to explain the automated rules concerning the generation and trading of the solar energy (Solar power generation, Electric power Transmission networks, power markets,…etc.). The keywords also concern “internet of things”, consensus and the most used cryptocurrency is “ethereum”.



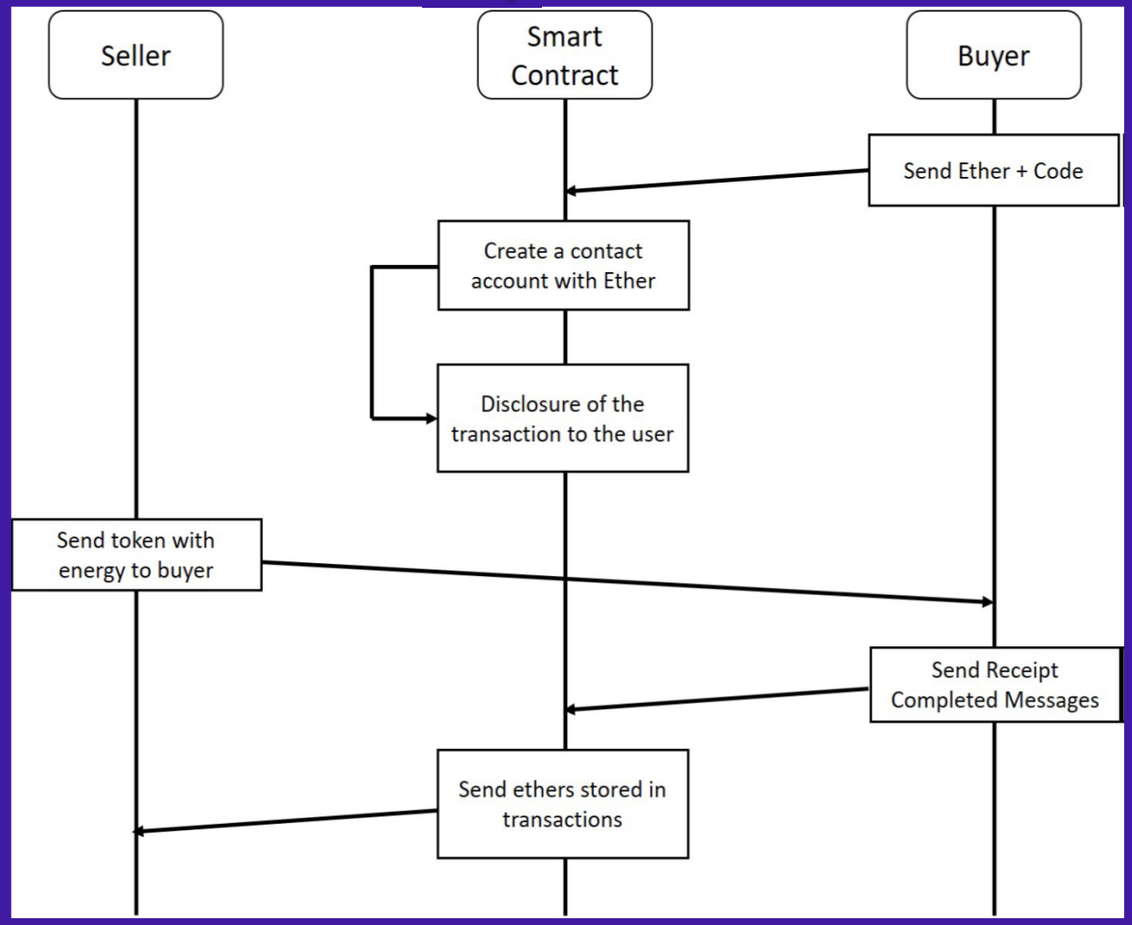
keyword	Nbr
Blockchain	38
Solar energy	15
Smart contracts	14
Solar power generation	12
Electric power Transmission networks	11
block-chain	10
Commerce	10
Power markets	8
Energy trading	7
intenet of things	7
Smart power grds	7
Electric inverters	5
IOT	5
Photovoltaic cells	5
Blockchain technology	4
Energy market	4
Ethereum	4
Intenet of things (IOT)	4
Peer to Peer networks	4
Photovoltaic systems	4
Consensus	3

Qualitaive Aspects Of the Analysis

1/ Energy generation or energy trading:

Twenty papers treat the problem of trading solar energy jointed to self-consumption,

The figure here shows the sequence diagram for the energy trading. In the energy trading platform, some participants have superfluous energy that they wish to sell to the platform as sellers, whereas others do not have sufficient energy to meet their demands and must buy the shortfall from the platform as buyers. Specifically, first, the buyer defines and sends Ether and code so that smart contracts can be created.

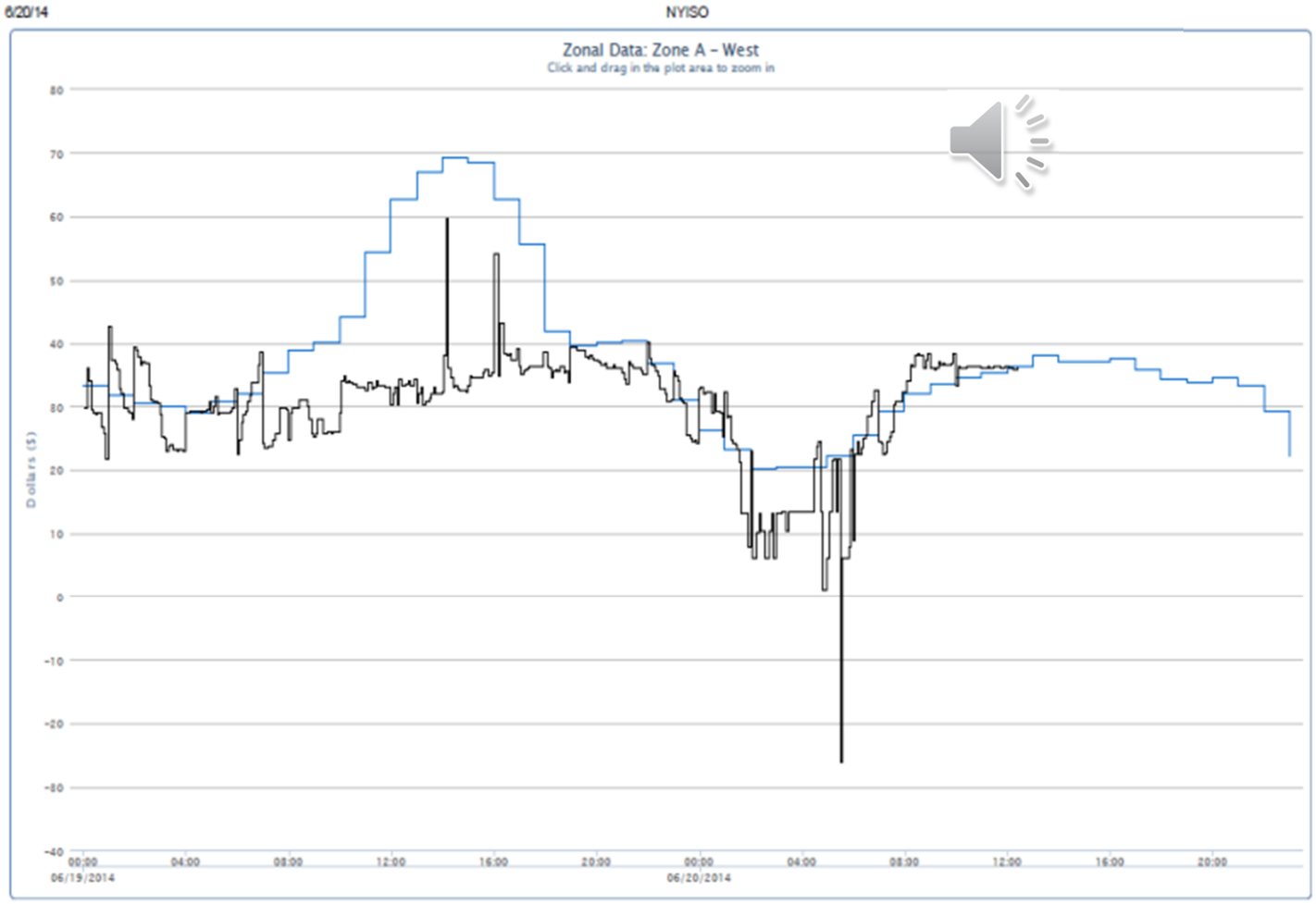


Solar Energy System 4.0 (IOT and Blockchain)

Establishing a system using IOT (Internet Of Things) devices thet produce the excess of energy. It consists of two parts: energy generation which maximizes the produced energy and energy trading using blockchain trading model ethereum based application. Enegy generation gains 35% [2]. There are 6 papers related to the IOT.

Other treated Ploblematics And Solutions

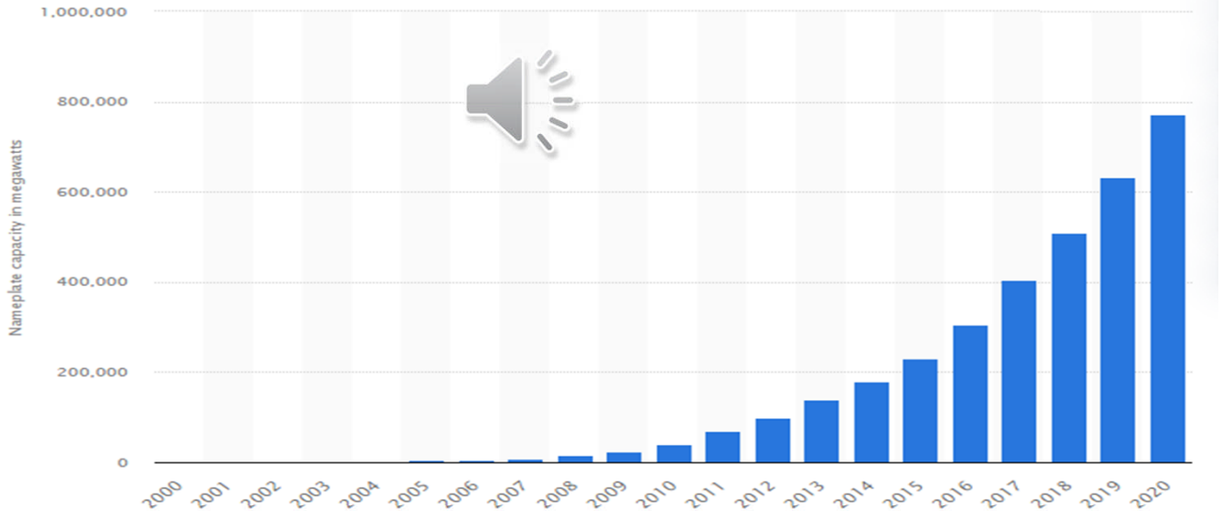
None of the existing studies a complete Blockchain based multidimensional P2P transaction mechanism fully open P2P trading mode and decentralized electricity price mechanism are adopted in day-ahead market, and P2P pool trading mode and electricity price mechanism based on supply/demand ratio are adopted in real-time market



An example of day-ahead market versus real-time market prices

Other treated Ploblematics And Solutions

Abandoning solar energy in rural regions and increasing voltage fluctuation have become more prominent [3]. To increase the local electricity consumption of the photovoltaic generation, the incentive mechanism using an optimal internal electricity price is proposed with blockchain technology. The simulation result shows that the comprehensive revenue is increased, and the local electricity consumption rate of distributed photovoltaic generation is significantly raised.



Global solar pv capacity 2020

Conclusion

We saw in this presentation how fast intrests in energy are growing. Many papers are published about this topic and many other technologies other than blockchain are integrated, which will lead to a mass distribution of the idea of exchanging excess solar energy with neighbours via a blockchain network using a proper coin. The main barrier here is how to transform a simple consumer to a prosumer. A P2P network is the most adequate architecture to support this platform. A cryptocurrency will make the trading more fluent. The prices of energy generally depend to the rules of offer/demand of the local or metropolitan market of solar energy. Knowing that the blockchain technology itself is a big consumer of energy, it is important to be autonome and a consumer of renewable energy like solar energy. This work may be usefull to developper of blockchain platforms and the producer of energy solar to take benefits both from their combination and to find exactly how to do so since the word blockchain can be difficult to combine with energy production In a future work, we will show other studies aspects from this collection of papers like: used protocols and consensuses, smart contracts, statistical methods, used data in blockchains…etc.